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THE

MULBERRY TREES AND SILK-CULTURE.

A SHORT TREATISE CONCERNING

Mulberry Tree Plantations

AND THE DEVELOPMENT OF

SILK CULTURE

IN THE UNITED STATES.

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BY

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Branch of Russian Mulberry.

(NATURAL SIZE.)

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1.—Concerning the Planting of Mulberry Trees.

As leaves are necessary before one can feed worms, a description of the different kinds of leaves suitable as food for the silk-spinners, is necessary.

There are three species of mulberry known respectively as white, black, and red, which are subdivided, especially the white, into several varieties. 1. The white (Morus Alba), a native of Asia, which attains a height of 40 or 50 feet, with the trunk of hard yellow wood, leaves cordate, oval, or lopsided in shape, smooth on both sides, and with a short stem; the berries are reddish-white, or black, some with almost too sweet a taste. In Italy and France this species is preferred for silk culture, but it has many varieties: *a*, the Spanish; *b*, the Italian rose-mulberry-shrub; *c*, the white large-leaved, obtained by grafting from the wild white; *d*, the Moretti-tree, from the garden of Count Moretti at Para, Italy; *e*, the *Morus Multicaulis*, a shrub-like tree; *f*, the Chinese *Morus Intermedia Japonica*; this last is very easily obtained from shoots. Many prefer these last three kinds.

L. S. Crozier says that the Moretti tree yields one pound of cocoons for every fourteen pounds of leaves, while of other kinds 16, 18 and 20 pounds are necessary.

The black mulberry (*Morus Nigra*,) of Persia, or China, is only good for the worms in the last period, while for little worms the white is by far the best. Its berries are violet-black, of pleasant acid flavor. The red *Morus Rubra*, a native of the warmer parts of North America, is good for nothing in silk culture; its berries are large and dark red, of pleasant flavor. The trees grow twenty to thirty feet high. The Mulberry brought to this country by the Mennonites of Russia nine years ago, and known under various names, belongs to the white variety, *Morus Moretti*; this at least is the opinion of Heese, of Berlin, President of the Brandenburg Silk Culture Society.

L. S. Crozier, a French grower, now living in Corinth, Miss., visited the Mennonite settlements of the West and says: "The hardy

so-called Russian Mulberry is the *Morus Alba* in all its varieties, but degenerated; it is a classic tree and the best cocoons can be obtained from it, if the eggs are of good quality."

I imported a large quantity of seed of this variety from Russia, and have also experimented with the French and Italian *Morus Alba;* these latter, however, froze down to the ground in winter, whilst the Russian mulberry was but little damaged.

This last was forced upon the German colonists in Russia by the despotic government a hundred years ago, and each colonist was required to plant a certain number of trees for silk-culture. At first the request of the government was only followed from fear, for it was backed up by the knout, but very soon the value of the tree was appreciated, and fifty years after this first experiment, every German farmer had beautified his land with thousands of mulberry trees from which many thousand pounds of cocoons were obtained. Even after an epidemic which killed off the worms and so reduced the silk industry that it has not yet recovered, the tree was still planted for its own sake, as hedge around garden and farm and for fire-wood. The tree was propagated there only by seed, and as only the best kinds then known to the Empress Catharine II, were sold to the colonists, the different varieties improved each other, and many wonderful sports occurred, one tree often having five different kinds of leaves.

I first learned here that the *Osage orange* of our hedges was good for the worms, and although it is often used to advantage, as for instance in the year 1882, when on the 22d day of May all the mulberry leaves were frost-bitten, and Osage orange was fed, till they grew again, it is not of great value in silk culture. This shrub will never take the place of the mulberry, because it is too thorny; it is easier to pick a thousand pounds of mulberry leaves than one hundred pounds of Osage orange leaves. My experiments in silk-culture have been made with the leaves of the Russian mulberry.

The Brandenburg Silk Culture Society, under the patronage of the German Empress, in its treatise on the mulberry tree and silk-culture, says: "If seeds of the *Moretti* variety can be procured (whose leaves are especially fine) one can count upon obtaining thorough-bred trees."

In collecting seed, take it only from the largest and finest trees, with large leaves, and from such as have not been plucked for several years. After crushing the berries and washing out the seed it should

be dried in an airy place in the shade (the direct rays of the sun are too hot and injure the germinating power); such seed will germinate at most until three years; if after planting in damp earth in warm weather it does not germinate in two or three weeks it is worthless.

Germination can be hastened by softening the seed in luke-warm liquid manure, for twenty-four to forty-eight hours. It must be planted one-quarter of an inch deep, and if a heavy rain occurs after sowing, the ground must be thoroughly raked over daily with an iron rake until the seed germinates, for otherwise the sprouts cannot reach the surface. No special advice applicable to every locality can be given. I plant the trees in ground that, two or three feet down, is so hard that the roots can scarcely penetrate it, and therefore I am able to plant eight feet apart, and may never have to thin out, while another, planting on bottom land in the same manner, might have to cut out three-quarters of the trees in ten years, and even then find his plantation too close. Where wood is scarce, as in the West, it is always better to plant close; 600 to 1,000 trees per acre, with rows eight feet apart, and four feet between trees. The labor expended will not be lost, for the wood can be sold for fence-posts or for fuel. If a straight trunk is desired the tree should be cut down to the roots in the second year, it will then grow four to eight feet the next season. For a one to four acre mulberry-garden, the best plan is to plant a hedge all around, so that in three to four years it can be used as a hog pasture; the trees thus give more fruit than any other tree, and the berries are particularly good for hogs during the months of June and July; they grow fat on them, and the labor of cultivating the trees is saved. This does not in the least interfere with their value for silk-culture.

Every farmer in the West should plant several acres of these useful trees, even if he cares nothing for silk; it will pay better than any kind of grain crop. The trees are so fruitful that in six years a single tree will often give many hundred thousand seeds.

Italian and French growers recommend the grading up by grafting of all varieties used in silk-culture, and in Lombardy their advice is carefully followed, and although I recognize the utility of this for those regions of high priced land, I do not recommend it for our country, because to me it is a matter of no moment, whether all the trees have large leaves or not. Small leaved trees I leave for fence posts, and pick from trees with large leaves.

Where land is worth $50.00 per acre and over, and where wood is not of great value, a different policy might be better. I have described the best or at least the easiest and simplest way of obtaining mulberry leaves in the West, viz., By planting hedges around the farm, or planting a great many trees to the acre, but will also describe another kind of plantation; neither one plan nor the other needs to be followed exactly. When in this book I say, this or that is easier, it does not necessarily mean that some other plan might not be just as good.

If high trees are preferred, the rows in the nursery should be cut down to the root in the second year, leaving one or two inches about the end of February, then only a single shoot should be allowed to grow, from which, during the first summer all side buds should be pinched off; by this plan, in a favorable season, the shoot will grow four to eight feet high in one year. The top can then be cut off at any height desired. In the next year a top can be made by cutting off all unnecessary twigs near the trunk, taking care not to damage the branch on which the twig grows, and other twigs can be shortened to any desired length. Some prefer to do this at the end of February, but May and June seem as good a time to me, for then the cut-off twigs and leaves can be given to the worms.

The mulberry tree is not at all sensitive. In Russia some silk-growers cut down the mulberry hedges every year to feed the worms, without damaging their trees' vitality. If the trees have first been planted in a nursery, it is easy to observe what trees have fine leaves, and the others can be improved by grafting or left for wood, while the better trees are transplanted. In order to grow very large trees, holes three feet deep and six feet wide should be dug one year in advance, and in planting a good layer of top earth, or in case of poor soil well rotted manure should be placed at the bottom of the hole, the trees should then be planted at the same depth at which they stood before transplanting. The roots should be laid straight, and enough water poured in to make the earth sloppy. They should be treated as other fruit trees and not plucked too closely during the first two years.

The proper distance apart in an orchard is 20 to 30 feet, and then grain can be grown between the trees. Well manured land helps their growth. In poor soil a distance of sixteen feet is sufficient. In Italy the favorite dwarf tree orchards are laid out in rows six-

teen feet apart and grain grown between. If possible, plant the rows north and south, as the leaves receive more sunlight than in rows east and west. Leaves grown in the shade are not good for the worms. In order to grow and keep good healthy trees, it is better, though not absolutely necessary, to change about in plucking; pluck either every other tree or every other row, year about, and even then I prefer to feed with cut off twigs, because plucking the leaves seems to damage the tree more than cutting off the twigs. When worms are little, and up to the third moulting, they need so little food that plucking the leaves for them does not hurt the trees. In Lombardy a tree is plucked nearly bare, but then the one year shoots are cut back to two to three inches. If cutting back is necessary, why not cut the twigs with the leaves? This seems to me better, where help is as expensive as it is West.

Short History of Silk Culture.

The value of silk culture has, in my opinion, not yet been properly or fully recognized in America. It would seem that the spirit of speculation which affects every kind of undertaking and turns into stock companies, in which millions are to be made, every enterprise, is largely responsible for this. Moreover, the press and its representatives know but little of silk culture, and often state that the capacity of a tree is very much greater than it really is. Swindling nursery agents are even more at fault. During the six years of my residence in America over one hundred newspaper articles have been sent to me of which only two did not contain exaggerations and mistakes. Most all state that two hundred mulberry trees on one to two acres will yield silk to the value of $1,100 to $1,300 in one crop, and that three such crops can be raised in one year.

In our county new nursery agents constantly repeat these same falsehoods, and as soon as unmasked in this locality reprint their stuff in other localities.

When either individual or company starts out in silk culture with such expectations and invests capital accordingly, it is only natural that the business, not yielding the expected millions, suddenly collapses.

For the Asiatics, whose standard of living is so very low, silk culture has been for forty-four centuries a very profitable business.

In the twentieth century B.C. at the time when Abraham is supposed to have been grazing his flocks in Mesopotamia, the Empress Si-ling-tschi of China busied her subjects with silk culture, and to-day China, India, Italy, and France furnish the most silk. 555 A.D. the first Chinese eggs were brought from India to Europe. The Emperor Justinian had persuaded Christian monks to smuggle eggs, hidden in their hollowed staffs from the country of the Seres in India.

For nearly 600 years silk culture was carried on by the noble ladies of Constantinople, Corinth, and Athens. In 1146 A.D. Roger I. brought the secret to Sicily, and from there the knowledge spread to Italy and Spain. Henry IV. of France had millions of mulberry trees planted in that country, and seldom has a king benefited his subjects in a greater manner. Since that time France has produced yearly from twenty to fifty million dollars worth of raw silk. In North Germany, after many obstacles, Frederic the Great succeeded in raising in the year 1774, near Magdeburg, Halberstadt, and Pomerania, 6,849 lbs. of silk; ten years later, 14,000 lbs.; nevertheless, notwithstanding magnificent subsidies by the Government, distribution of prizes and premiums, and notwithstanding the praiseworthy perseverance in silk culture of the Germans themselves, the wished-for results have not been obtained. The North German climate does not seem suitable.

In Russia the Empress Catharine II. caused experiments to be made by the German colonists of southern Russia. By an order of the Empress these latter had to buy from the Government millions of little mulberry trees at about five cents apiece. Although it took several years to grow the trees on the *steppes*, silk culture finally developed to an extraordinary extent, but about thirty years ago devastating epidemics utterly destroyed it. I made several experiments there with fresh eggs imported from Japan, but they only remained healthy the first year, and in the second gave no good cocoons.

Here in America, as far as my three years' experience goes, and that of my compatriots in Minnesota and Kansas, there seems to be no reason why silk culture should not succeed. Thus far there is no steady market for cocoons or raw silk, although we are sometimes promised $1.25 to $1.75 per pound for cocoons. I would recommend silk culture as very profitable if the cocoons were paid for at the rate of $1.25 per pound at the nursery, for at that price a person could earn

from seventy-five cents to $1.00 per hour of labor given. If our wiseacres in Washington would furthermore support us with a good protective tariff on raw silk, silk culture would increase largely.

From my own experience, with regard to health and strength of silk worms, I am inclined to believe that there are regions in America where the culture of silk worms might be begun to raise eggs to supply the French and Italians, who now draw their supply at great expense from Asia. If this should be, it might yet happen that two acres of mulberries in one year would yield $1,000 to $2,000 of eggs, or even $4,000.

In the year 1871 an Italian, Louis Sada, of Lombardy, raised in Chili and Peru the Milan and Japanese worms with such success that the Representative of the German Empire, Mr. Bunsen, sent to his Government a portion of the eggs. What became of them I have not learned. Louis Sada writes as follows: "In Chili the cocoon lost neither in form or size, nor did the quality of the silk deteriorate. In Peru I noticed the cocoons became smaller, but the quality of the eggs and silk was better than in Chili." The transplantation of worms from one region to another has been therefore crowned with success.

Eggs and How to Keep Them.

Those wishing to raise silk worms should begin with a few eggs only, perhaps one-fourth ounce; this is sufficient to become acquainted with the nature and customs of the worm. This will give him an opportunity to make preparation for the next year, if it is desired to increase the business, to make calculations as to the wants of the worms with regard to shelves, space, foliage, warmth, etc. As much or more care should be taken as with other breeding, in order to get good worms. This the Europeans know from experience, since they procure fresh eggs annually from Japan, which pass Omaha, Neb., generally in the latter part of February on their way east. Those having a good quality of eggs may keep them in a dry cellar in winter, or in a north room that is not heated, and from which they must be taken to the cellar in spring when it begins to get warm. Down to zero Fahrenheit does not destroy the eggs, but it is better to keep them near the freezing point, for if kept warmer in winter they hatch too early. If you have no dry cellar which is free from mould keep the eggs in the winter at least sixty to ninety days in a cold room, since the least mould will produce sickness.

The preservation of eggs in ice cellars to keep them until late in the summer, has not proven practicable in my experience. The development of the worms can be forcibly held back in this manner, but this interference with the natural development reaps its own punishment.

The beautiful blooming Cape Tulip flowers in South Africa when there, in the last days of the month of October, spring appears. Brought to Europe, according to J. G. Beer's account of horticulture (Exposition in Paris, 1867); when brought to Europe, it flowers in South African spring time; and when with us all growth has ceased and fallen into winter-sleep, this tulip begins to grow as if by magic, and this whether laid on ice, or warm, whether dry or extremely wet, whether in the light or in the dark, the tulip sprouts, for its spring has come. But all efforts to make it sprout during its long sleep are unsuccessful till October comes. Silk worms, eggs show similar traits. Laid in the latter part of June or July, the worms do not develop until the next spring, and no person has yet succeeded in hatching them sooner; but for some unknown reason, some females lay eggs which hatch in a few days; these are the so-called bastards, which breed three generations in a year. In China and Japan the kinds called Bivoltini and Polivoltini originated in this manner. These species were imported to Europe lately, because they suffer less from the diseases existing there. I never succeeded in raising as good cocoons from them as from others. The cause may be found in the fact that in July the foliage is mostly affected with blight; and in spring, when the leaves are free from blight, I never experimented with this kind.

As soon as the development of the embryo takes place, and not until then, can we hatch the worms at any time. According to French breeders, the embryo develops in the middle of January, and the eggs should after that time not be exposed to a temperature of more than 50° Fahrenheit. The transportation of eggs should not take place in warm weather (unless it be short distances), as the time when they want to hatch, to lay the eggs on ice to keep them back until June, is possible, but then they will never hatch, because the worm has developed despite the cold and is chilled to death. To place eggs in an air-tight place, as is done with seeds, which keeps them for years, will not answer, in two months they are spoiled, the evaporation of the egg smothers them. To hang them in the cellar in a gauze bag is the

best, but if spiders, which like eggs, are about, it is necessary to put a wire gauze around the bag or place the same in a tin box with air holes in it. With fresh well water I loosen the eggs from the stuff on which they are laid, as soon as the laying is over, and then wash with water, dry in the shade, changing them over to fresh dry blankets, stirring them up. When thoroughly dry I pour them into a gauze bag and leave them till winter is over. I state this, knowing that some will contradict me, as they think it is better to leave the eggs on the linen or paper where laid until hatched, as washing is considered injurious, but this has not been my experience.

From time immemorial Chinese breeders have made card-board from the bark of the mulberry tree, and on this the eggs are laid. It is then covered with ashes of mulberry wood and the paper is dipped about New Year into salt or river water, or lye of mulberry wood ashes, and the eggs washed several days in succession, then (according to F. Haberland, Professor at the Royal Agricultural College of Altenburg, Hungary, in his work on Silk Spinning Insects and their Diseases, Vienna, 1879), these cards are hung out in the air to dry, whereby they are exposed to the cold wind, rain, and snow for a few days, that the future worms may become stronger and hardier. If the eggs have to hang in wind and storm to produce a strong breed (superstition may have much to do with this, although it is done without injury to the worms), the washing immediately after the laying of the eggs may have a similar good effect. It is certain that these eggs laid on card-paper have plenty of air, while the air has not the same access to those preserved in bags; it is therefore necessary to make the bags small and to pour in them about three—at the most, five ounces, then the eggs will preserve as well as on card-paper or cloth.

I only want to state here, that eggs can be preserved in bags, and that it may be as well to leave them on card-paper or cotton cloth, then to wash them off, but it is more trouble to preserve such pieces of cloth and keep the spiders away than it is to preserve eggs that are washed loose.

Silk Culture and its Requisites.

The main requisites for the culture of silk worms are: Healthy food in abundance, plenty of warm shelter, and careful nursing.

(*a*) *How to Obtain Healthy Food in Abundance.*

The first requisite is plenty of good mulberry leaves as food for the worms, as has already been indicated in the description of the tree, so that food may be had as near and fresh as possible. In the first year try only a few eggs, about the fourth of an ounce, from which 8,000 to 10,000 worms will hatch, and these will need about 500 pounds of leaves. A beginner needs as a rule more leaves than an old hand for the same number of worms, and must be careful not to raise more worms than he can feed. Worms eat in their last period before spinning more than three times as much food as in the preceding four periods. If the ordinary estimate of 1,600 pounds of leaves to one ounce of eggs is correct, in the last period 1,100 pounds of leaves would be necessary; the real proportion is, however, about as follows: in the first age the worms from an ounce of eggs need at most ten pounds, in the second 24 pounds, in the third 110 pounds, in the last more than 1,400, a total of more than 1,800. The beginner whose young hedges, bushes and trees had supplied him the necessary 500 pounds up to the fourth age, would find himself in great straits to supply the necessary 1,600 pounds for the last age.

I warn the grower again concerning the necessity of good healthy food, for although the leaves of the unimproved varieties of white mulberry give good food, the large leaved varieties, if not too coarse, especially the Moretti tree, are to be preferred, because they give less trouble in plucking; also that the leaves of detached and high trees are better than those of close standing, shaded trees, and also that the leaves of young shoots, however good for young worms, cannot replace the leaves of older branches for the last age, and finally, that in case of necessity worms will not reject any kind of healthy mulberry leaf, not even that of the black mulberry; but do not in such cases thrive and spin well. Worms die if fed on dwarfed, seared, frozen leaves, or leaves grown in valleys, or fermented leaves from close packing; in short, on any kind of spoiled leaf. Therefore never let a supply of leaves on hand become damp and mouldy; but preserve it in well ventilated cellars. If the leaves have been soaked by the rain or by heavy dew, they should first be dried in a barn or garret, being turned over frequently, and then removed to the cellar. Even here they should often be stirred up, especially in the morning and evening, when it is cool; having all windows open in order that the

generated gasses may escape. In rainy weather I pluck only sufficient for the daily need, having my trees right at hand, and even on Sunday I feed directly from the trees.

(*b*) How to Provide Shelter and Procure Necessary Apparatus.

A warm shelter for the worms, and a proper arrangement of the same, whether room, hall, or garret, with conveniences for artificial heating, and a proper supply of shelves, frames, and scaffolding, is necessary if the business is to be profitable.

In cold climates artificial heat is often necessary to equalize the sudden changes of temperature, because the activity of the worms diminishes during cold weather, and they are thus checked in their development, and such checking or laming is particularly disastrous at the moulting or spinning periods, although experienced growers have raised worms during the three last ages in unheated barns and sheds in a cold climate. This is always attended with risk, and such an experiment ought not to be tried by a beginner. Even in Italy fire-places are provided to regulate the temperature. Some growers, without conveniences for heating, have succeeded by hatching the eggs later and carried to a good end the care of the worms by keeping them at night in cow and sheep stables, where the animal warmth moderated the outside temperature; or by putting them in garrets under thatched roofs, which are better than tile roofs. In my home in southern Russia we used the cattle stalls in silk culture during the third and fourth moulting; but first cleaned them out, having turned out the cattle. It is always best to so arrange matters that worms and leaves develop together, so that not much foliage is necessary after the 20th of June, late plucking and cutting being very injurious to the tree. Sufficient shelter for the worms must be provided. Some are afraid to begin for fear of not having room enough. Others start with so many worms that they have no place for their development. The size of the space, however, is not so important as its arrangement. Many a grower will raise 30,000 to 35,000 worms in a room 12x10x8—about 1,000 cubic feet. Great skill is required to manage so small a space, and I would advise a less number of worms, as they are easier taken care of, and it is easier to provide fresh air and cleanliness. The best and most economical arrangement

of the room is as follows: Fasten between floor and ceiling, upright ladders, so that across the rounds lath or thin boards can be laid, upon which the frames are placed. After the third moulting the expense of frames can be saved by placing the worms upon woven willow frames. The several stories of the scaffolding can be one to one and a half feet apart. A minimum distance should be nine inches, and only then when the frame-work is of netting or basket work, which permits ventilation from below. The scaffolding should be about eight feet high, twelve feet long, and have four stories; the lowest two feet from the floor on account of the cold. The frame should be three feet long and two feet wide, so that each division would have five frames; twenty-five frames in all. This will give a surface of 150 square feet; entirely sufficient for the worms from one-fourth ounce of eggs. Five to six hundred square feet are necessary for the well-being of the worms from one ounce of eggs during the last stage. The frames can be made of four laths; the two shorter mortised into the longer ones. Between the lath stretch twine, on which lay or paste strong perforated paper or paste-board. The frames are more durable if strengthened by cross-pieces, and covered with linen nailed to the lath. If the frames are only 3x2 feet stretched linen is enough without cross-pieces. Such frames last many years. For the last age one can save frames by placing the worms on beds of plain boards provided with borders.

Ventilation and heating go together, for if the stove is in the room the air is renewed as soon as there is a fire. On warm days open door and windows. Ventilate with great care close and stuffy rooms, and protect the worms from the rays of the sun, as they naturally avoid strong light.

(*c*) The Silk Worms and Good Eggs.

(*Moth Eggs.*)

After providing proper apparatus the next requisite is good eggs. Generally eggs raised by small growers are not good. Draw your supply, therefore, from large growers, with well established reputatation, who only keep in stock the best kinds. The two principal species are those that give yellow silk and white silk, respectively, each of which has its varieties. In France eight varieties of yellow and three of white are distinguished. Of the yellow I prefer the

large cocoons; of the white the *sina* kind. The white grow faster and eat less, but the yellow give more silk and are hardier. The price for white silk is often higher than for yellow, and although the difference will probably increase on account of the growing demand for light colored silk, my advice is to begin with the yellow. The yellow variety is well marked during the last age by the yellow feet of the worms.

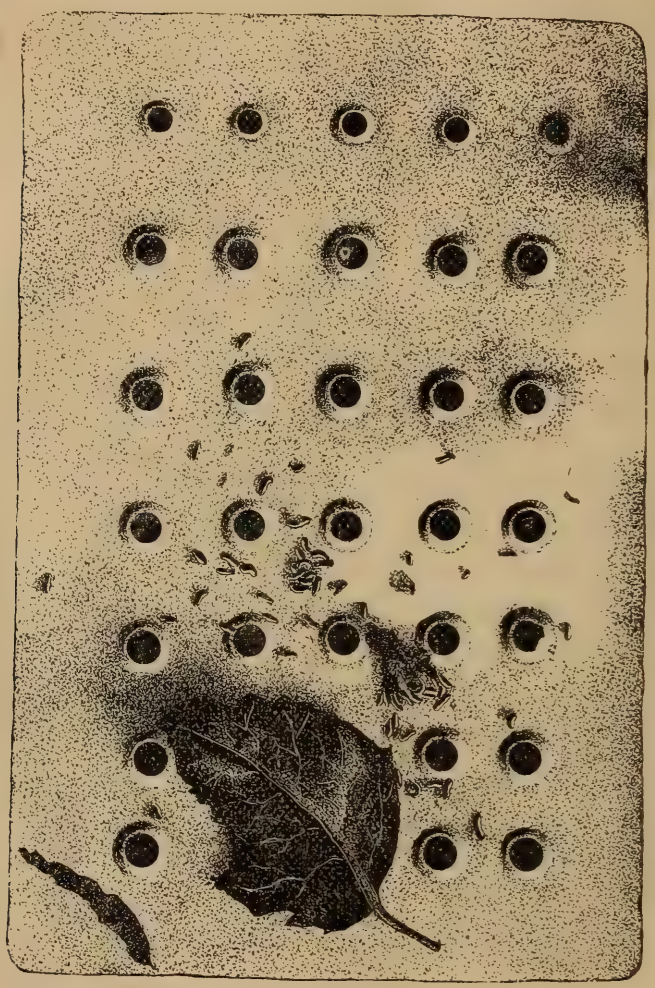
(*d*) Care and Nursing.

(*1*) *Care of the Eggs and Hatching.*

Home raised eggs, as well as imported, should be kept in an airy, dry place, protected from mice and spiders by wire gauze. The proper time for hatching is when the first leaves of the mulberry have sprouted. Place the eggs then in a warm room, beginning with a temperature of 60° Fahrenheit, increasing it daily 2° to 3°, until a temperature of 80° is reached, being careful to keep the air damp by sprinkling the floor or hanging up damp cloths, or placing under the frames a dish filled with water. By careful observance of these rules uniform hatching will be attained. Lay the eggs in shallow boxes or scattered on paper, and place them in some quiet spot, not too near the fire, nor exposed to the sun, low enough to be easily seen. The eggs become lighter and lighter in color, and shortly before hatching are almost white. When hatching, lay over them perforated paper or coarse tulle. Beware of tobacco smoke, as it kills both eggs and worms.

(2) *Nursing of the Worms Till They Spin.*

(a) FIRST AGE. FROM HATCHING OF THE EGGS TO COMPLETION OF FIRST MOULTING.



Worms creeping through paper the first morning.

(NATURAL SIZE.)

Soon the paper or tulle will be dotted with little hairy dark brown worms; feed them with tender little leaves. When covered with the worms, carry the leaves on a sheet of paper into the nursery on to their frames, if the room is warm enough. These are the first comers, ordinarily few in number. The next day provide a fresh supply of young leaves over the hatching boxes; many chop up the leaves, which is not necessary. Carry the new comers hourly away, but do not mix them with the first. Continue this from day to day till the stragglers of

the fifth and sixth day are all hatched. The more eggs, the more careful one must be to separate the worms according to hour and day, in order to save labor later, in changing and feeding, and also in order not to disturb those moulting; in short, keep together worms of the same age. Many breeders check the development of the first comers by keeping them in a cool place and take particular care of the last comers in order to secure uniform development of all; others throw away or give away the last comers as worthless, and some reject the first comers, although they are the very best; others again take particular care of these for breeding purposes. The first hatched are generally the best, the last hatched the poorest. The mandibles of the little worms are very tender; they can only eat little tender leaves and if fed on large leaves do not thrive. If the worms are behind the leaves in age the same care must be exercised in the second age, which can be done, as the mulberry is constantly growing fresh leaves. As soon as all the worms have been removed to the frames, provide abundant and suitable food. It should be plucked daily, in the morning, strewing it over the worms four to seven times a day. Some growers prefer chopped leaves, which they strew over the little worms with sieves, but I do not. Frequent feeding and not more than they can eat at a time, one meal late at night and another very early in the morning on yesterday's leaves is recommended. A good rule for feeding is: tender, light colored, fresh, cool—not damp—leaves often, but not too much. By feeding only the tenderest leaves, the smallest worms get along without having them chopped. The young worms eat with increasing appetites up to the fourth day, eat less the fourth and fifth, and cease entirely the fifth, or sixth, or seventh day, lying quite still with raised heads, twenty-four to thirty-six hours, until the first moulting is accomplished. The fourth day, the time of the greatest appetite, is the best for cleaning the frames, by changing the worms on fresh leaves over to a new frame and then clean the frame from dust and the remains of leaves. The easiest way to change them is to lay a fine net, or perforated paper, or tulle with fresh leaves on it, over the old frame; nearly all the worms creep through, the stragglers can be transferred afterwards on other leaves or twigs; if sufficient nets are on hand it is better to leave them under the caterpillars than to shake them off, which takes not only time and care but is apt to injure some of the worms. Do not change them if they are already

moulting. Artificial helps are only necessary after the third moulting. Up to that time it is easy to transfer them from one frame to another by changing the leaves, without running the risk of hurting them by the weight of nets and paper. The duration of the first age varies from five to eight days according to temperature; in cooler weather they eat less and therefore must not be fed so much. The temperature should be kept at about 75° Fahrenheit, and if at night it falls to 60° or 70° warm the room with a fire. The worms eat in this period nine to twelve pounds of leaves per ounce of eggs; at the end of this age the worms lose the dark and hairy appearance, become white near the head, and at moulting are nearly four times as large and fourteen times heavier than at hatching. This is a critical period and they require great attention; they must neither be disturbed nor fed. Fastened with a few threads they hold up their heads, behind which the skin becomes wrinkled and transparent, so that the new head can be seen; the skin suddenly bursts and the new worm creeps out, mottled gray in color with broader head and mandibles.

When moulting be careful to regulate temperature and ventilation, by means of gauze windows or frequent opening of the doors and windows, if the outside temperature is not below 68°. They will also moult with less warmth, but so unequally as to cause great trouble and danger from protracted fasting; neither should it be too warm. If the worms have been well cared for and well fed the day before moulting they come out of the skin fat and round.

(*b*) THE SECOND AGE. FROM THE FIRST TO THE COMPLETING OF THE SECOND MOULTING.

After the first moulting the worms need a warm, clear, dry, stirring air, until they are dry and their mandibles have had time to harden. After two or three hours the temperature can be diminished, and their frame covered with tender large leaves or with little twigs with two or three leaves on, and I prefer the latter, in order to transfer them to new frames. The frames and nets can be used with larger holes. The following use of the nets saves much labor in the fourth and fifth age. The nets are to be stretched on frames of the same size as the ordinary linen frames. On each linen frame lay a net so that the worms are not touched, cover the net with picked leaves. In a short time nearly all the worms will be found on the fresh leaves, place

frame and net on the work-bench, that should be in every room, lay a fresh frame upside down on the net and by turning them over, worms and leaves are transferrred to the fresh frame. Avoid all jars in such transfers. Even if a few worms remain on the net it makes but little difference, as the net will probably be immediately used to transfer others of a like age. Sometimes not a worm will remain. A sufficient supply of nets will be found a great convenience, but they must be of assorted sizes of mesh to suit the worms. If old fish nets cannot be bought, it is not hard to learn to make new ones. A stiff frame is better than a loose one, as the latter requires two persons to make the change.

If the worms in each frame are well assorted they will all moult nearly together. Those first through can work ten to sixteen hours without food, till the others are ready. After moulting much food must not be given. In changing them over give more place by taking the net away when only half the worms have crept through, and providing a fresh net for the others. In this age, that lasts five days, and in which the appetite increases and diminishes, they should be cleaned on the third day, because on the fourth many have already begun to moult. They should be fed six times daily with tender leaves, of which they will consume altogether twenty to twenty-four pounds per ounce of eggs. Their length increases to half an inch, they become four times as heavy, and their backs are marked with the characteristic pincer-like marks; the moulting takes place as before.

(*c*) THE THIRD AGE. FROM THE SECOND TO THE COMPLETION OF THE THIRD MOULTING.

Up to this stage the worms are so small that many breeders leave them in the hatching room, but now more space is so necessary that they must be transferred to the nursery, where the temperature must be about 70°, but the stragglers from the second moulting should be left in the warmer room and be better fed so that they can catch up.

During this age of seven days they should be cleaned, with the room warm, on the third and fifth day after the morning feed, and should be daily ventilated, and fed four to six times, no longer with chopped or little leaves. Many begin to moult on the sixth day, be-

come one inch long and yellowish-white in color, and are four times as heavy; seventy-two of them weigh half an ounce, and they need 100 lbs. of leaves per ounce of eggs. The moulting goes on as before.

(*d*) THE FOURTH AGE. FROM THE THIRD TO THE COMPLETION OF THE FOURTH MOULTING.

The worms now need a temperature of 68° to 72° Fahrenheit, and must be fed abundantly four times daily. As both the leaves and the worm dry out, not only the frames but also the room should be daily cleaned and well ventilated. They should be given more space every second day, for unless great care is exercised the seeds of disease, which develop in the fifth period, are now contracted. They should be fed on hedge and shrub leaves and the lower leaves of the trees; the great mass of the strongest leaves should be saved for the next period. Even in this age they eat ravenously, especially from the third day after the moulting, when the hurry begins. They use in six or seven days 260 lbs. of leaves per ounce of eggs. On the seventh day, having attained the length of one inch and a half, they will nearly all begin to moult, and if the temperature and ventilation is good will pass through successfully.

(*e*) THE FIFTH AGE. FROM THE FOURTH MOULTING TO THE SPINNING.

This age determines the success or failure of the whole experiment. If the worms become sick or die, trouble and expense has been in vain. Care and diligence are to be redoubled, not only because the marvelous gluttony of the worms requires so much more work, but because also the spinners must be provided for. In this last age the worms eat more than three times as much as the total hitherto, namely, 1,200 to 1,700 lbs. per ounce of eggs. The temperature should be kept at about 70°—some prefer 75°, and they should be fed three times daily with strong leaves from the crown of the trees. He who supplies insufficient food now loses two-thirds of his silk harvest. If well fed they will begin to spin in seven to eight days, otherwise in nine to ten days. They must not be allowed to crowd each other; good ventilation and great cleanliness are more than ever necessary. See that the air does not become too damp; open the windows fre-

quently; place around the room unslacked lime, which will take up the excess of moisture and carbonic acid. If (which is much rarer) the air should be too dry or too warm, the floor should be sprinkled with water, the leaves should be dampened and wet cloths should be hung up.

The worms are very sensitive to electric and thunder storms, and are especially affected by the heat preceding them; if ready to spin they fall backwards as if lamed, and many perish. It would seem as if the electricity of the air affected the fluid silk in the worms very much as it affects milk. In case of storm, close all windows and doors; light, if possible, a fire in order to create a draft, and if this is not possible fan with cloths and sprinkle the room with cold water.

About forty-eight hours before beginning to spin the worms reach their greatest size. Many of them are forty lines long, and seven will average an ounce in weight. From now on their appetite diminishes, they purge themselves, weight and size decrease, their bodies become transparent, especially underneath. When they become uneasy, raise and wave their heads, begin to creep upwards, and seek out dark corners, it is a sign that they are about to spin the first threads, which are to fasten the cocoon.

[3] *How to Treat the Spinners and Set the Heaths.*

Where many of the worms exhibit the preceding symptoms put the others on short allowance, as some of them are apt to develop dropsy instead of spinning. When ready to spin, the silk thread is spun from the mouth, and wherever they go they spin it after them, thus wasting much silk unless they speedily find a suitable place. The necessary number of spinning heaths should now be set up. If by judicious feeding all the worms are ready to spin together it will be hard to provide all at once the necessary number of heaths, but they mostly ripen by degrees. The heath consists of bundles of twigs in whose forks the worms find space and sufficient support to begin the cocoon; especially good are birch twigs, broom, rye straw, heather, shavings, bean and pea straw, and oak twigs with the dry leaves, in whose hollows they like to spin; between these bundles, which ought to be fastened in the various stories, the frames full of worms are pushed, and soon the spinning begins. Supply the worms according to their needs, and do not hurry those that are not willing to go, as

handling does them no good. Some growers make a kind of tray of paste-board, in shape like a dust pan, covering it with white paper and narrow enough to fit between the bundles; this tray is covered with fresh leaves, and after collecting all the worms ready to spin they are suddenly jerked between the bundles; they suffer less from this treatment than if held in the hands. If the scaffolding is not stronger than that described in the first part of this treatise, the different stories can be strengthened by thin boards or empty frames so that the bundles can be placed between them. If there is not enough place for the frames and worms, the nets and perforated paste boards can be used, in order to place the worms between the heaths. Around the bottom of the heaths, chopped straw, chaff, or saw-dust should be scattered to the depth of one inch, in order to absorb the liquid discharged by the worms just before spinning. Those that will not climb can be covered with pea or bean straw or other material and they will spin where they are; they should, however, be aided in following their instinct, by erecting many climbing poles or twigs which lead up to the bundles. With proper care double spinners will occur, and the picking of the cocoons will be an easy matter. A good and economical plan of preparing spinning heaths is to fold straw-paper or ordinary packing-paper so that the sheet presents this edge

Each hollow is three-quarters of an inch deep and wide, and the worms like to spin in them. During the spinning the air should be pure and not too damp; the temperature should be as near as possible 72°, as this facilitates the flow of the silk. If it is cooler many change to chrysalides without spinning. Healthy worms complete their cocoons in three days, and after the last have begun to spin, at least that time should be given before any are picked.

HOW TO PRESERVE THE WORMS FROM THEIR ENEMIES.

The enemies of the worms are sparrows, flycatchers, singing birds, and especially chickens, which eat them greedily, also rats and mice, which devour not only worms but also cocoons. Mice and rat holes should be stopped up with broken glass and mortar, and otherwise destroy the vermin. Cats can be kept but not in the nursery itself, as

they also eat the worms and otherwise disturb them. As ants often trouble them, boiling water should be poured in the cracks through which they may come. Spiders are very dangerous and must be sought after daily, as they get in through the windows and between the leaves. Horse-flies, wasps, and hornets also trouble them, and are best kept out by netted windows.

[*f*] *The Silk Harvest, and How to Reap It.*

I.—HOW TO TREAT THE COCOONS.

This embraces three processes: (1) The picking and sorting, (2) The killing, and (3) reeling of the cocoon.

(*1*) *The picking and sorting.*—At the earliest, three days after the last worms have spun their cocoons, the heaths should be torn down and the cocoons picked. The outer loose floss silk should be collected by itself and saved. The cocoons are sorted in three divisions: (1) good and solid, (2) bad and soft, and (3) those selected for breeding, viz., the largest and best. The better as well as the poorer kind are to be sold or reeled. If they are sold according to weight it should be done very soon, as they lose daily; if they are reeled it should also be done soon before the moths creep out.

As everything cannot be done at once, and there is danger in delay, as the moths pierce the cocoons in two to three weeks after spinning and thus spoil them, the chrysalides must be killed.

(*2*) *The killing.*—The moth, when fully developed, dissolves the gum at one end of the cocoon by means of an acrid secretion that turns brown upon exposure to the air. It then bores through the silk and tears it so badly that it cannot be reeled and has lost its value, although it can still be used for coarse hand work. The killing is a very particular job, as the cocoons must not be damaged; it is best done by exposing them to either dry heat (baking) or steam, either of which suffocates the moth, it could easiest be done by boiling the cocoons, but this dissolves the gum and prevents the reeling, and moreover it is then difficult to dry them in large quantities.

In baking, place them in an oven heated to about 120° Fahrenheit; bake them neither too long nor too fast, as otherwise they will not reel; place them in little baskets in the ovens or on frames, such as are used in drying fruit, to the depth of two fingers; soon one will

The Silk-Reel as it is used in Southern Russia and by myself.

hear a loud crackling, caused by the spasmodic movements of the crysalides in the cocoons; this ceases at the end of half an hour; some take them out immediately, others leave them a full hour to make a sure thing of it. After the baking the cocoons should be piled together and covered up closely, which both increases the chance of suffocation and also dampens the cocoons from within and thus makes them soft and pliable. After cooling they should be dried in a well ventilated place, and then they will reel easy. Evaporation of water during the baking is to be recommended, as it both helps to kill the chrysalides and prevents them from drying too much.

The killing should be thorough, as otherwise great damage is caused by the liquid from the chrysalides, which ruins the cocoon and prevents the reeling. To be sure that all are dead cut open one of the blackest or double cocoons and touch the chrysalid with a red-hot wire; if it moves it is not yet dead. The danger of a greater heat than 120°, or when baked too quickly and too long, seems to be less the drying and burning of the thread than of the gum, which then becomes insoluble in water; therefore the killing by steam is preferable, because the boiling point can be reached and death made certain without injuring the cocoon. In this method the difficulty is in drying afterwards, for if not well dried they become black and mouldy and spoil. He who owns a stationary boiler should proceed as follows: Take a sieve of gauze, fill it with cocoons three or four deep, cover them with a woolen blanket, place it over the boiler so it does not touch the boiling water. The hot steam penetrates them and in five minutes they are all dead. Pour them on to a blanket, spread them out and dry them in the shade. Or another plan is to place a barrel, open at both ends, over the boiler. Putty it down to the boiler or make it air tight with wet clothes; fill the barrel with flat baskets filled with cocoons. Cover the top tightly, leaving a few holes, and steam for half an hour, when all will be dead. In five minutes take out the baskets, spread the cocoons on a sheet and dry them well. Be careful not to let hot water fall on them. Spotted cocoons should be first sorted out to prevent the staining of the others.

(*3*) *The reeling of the cocoon.*—We advise all, not acquainted with the art of reeling or provided with the proper machines, not to attempt to reel, but to sell their cocoons to some practical reeler. Growers who have many double cocoons or inferior cocoons which

they cannot either reel or sell, or who have many pierced cocoons, should know that these can be used as also the cocoon skins and floss silk by boiling them with soda or lye. The gum is thus all dissolved and the dried cocoons can then be combed and carded out so as to give an excellent silk yarn.

II.—MOTHS AND EGGS.

From poor eggs only poor worms come, and from moths of poor worms only inferior eggs are obtained. As poor spinners can be graded up by care, so the very best breed can deteriorate from want of care. The greatest circumspection is therefore necessary to obtain good eggs. After collecting the first hatched worms and giving them particular care one should select of these the first and best spinners and sort them carefully out; if this was not done at first sort from the whole lot the largest, evenest, finest spun, richest in silk, and at both ends stiff cocoons, and of these again select the very best. Double cocoons are worthless for breeding. One pound of cocoons will yield 1 to 1½ ounces of eggs and a little less of selected eggs. Choose as far as possible an equal number of males and females; the male cocoons are generally smaller, contracted in the middle, and pointed at the ends; those of the females are larger, bigger around and flatter at the ends; collect them on different frames in a room with a steady temperature of about 70° and darken it as soon as they begin to come out, only using light in handling them.

When they begin to creep out, they should be watched between four and eight o'clock in the morning, as most of them pierce the cocoons between five and six. The males (smaller, broad feelers, pointed bodies and active,) and the females should be brought together on suspended pieces of linen, muslin, cloth, &c.; as soon as they have emptied out the red juice, lay under the suspended pieces similar stuff to catch the falling eggs. For those who wish to raise only one or two ounces of eggs, it is sufficient to place the impregnated females on a sheet of paper where they will lay. The laying lasts forty to forty-eight hours at a temperature of 75°, and sixty hours at a temperature of 68°. Keep away chickens, cats, wasps, and hornets.

It is well to keep each day a certain number of males in reserve to use them the second day, if more females than males are hatched then. Unimpregnated eggs remain light-colored, while the others change from yellow, through reddish-gray to slate-gray, and yellow-spinner eggs have a yellow-green sheen.

The above instructions are in substance those given by the Brandenburg Silk Culture Society. In Southern Russia we never followed them to the letter, but the greatest care is always repaid. In order not to frighten the beginner, I will describe a simpler plan of silk-culture as it is employed in Turkey. Twigs, as they come from the tree, are placed for the worms from one to two feet long, the ends cut off so as not to pile too loosely; the cut leaves are dropped in between the twigs, and the nest is only cleaned after each moulting, and a good Turk does not clean it at all, losing in consequence many worms. Professor B. I. Dufour, many years in Turkey, thinks the system of cleaning but once after each moulting very good, as the worm is compelled to hunt around for its food and thus exercises. He says the Turk begins by laying the twigs on the floor; I think one foot above the floor is better in order to collect the fallen worms and clean away the dirt; but Professor Dufour says "it is owing to the Oriental method alone that the

Turkish system of Feeding.

(Cocoons and worms in Reduced Size.)

Turkish silk worm has never suffered from disease." At the time of the last moulting, the nest is one foot high. Instead of spinning-heaths, Dufour recommends four feet high oak branches; the worms like them, but where oaks are wanting, asparagus, straw, and other dry twigs are good. Feed four to six times daily; six times is preferred by some, as the leaves are not always equally distributed (that each worm may get its share). It is preferable to feeding three or four times, because if some worms do not get their portion three or four times they have three other chances of helping themselves. With only two meals a day, the worms do not prosper as they should. Chopping the leaves is done by many in Japan and China until the third moulting, but I am not in favor of it, and deny that it is better, although the cause of my aversion may be that I lived so near the Turkish border.

Prominent Chinese growers feed the worms on the first day once every half hour, twenty-four times in all; fifteen times the second day and ten times the third day. After the first moulting, the first day even three meals per hour are given; on the first day after the second moulting, two meals per hour, and after the third moulting three meals every two hours. After the last moulting, when greediness has set in, they feed continually. Attendants go from frame to frame with baskets of leaves and fill up wherever they see an empty place. Many Chinese authors think it better to feed night and day, for they think that thus the worms spin earlier; they measure the expected amount of silk by the number of days of growth: from those spinning in twenty-five days, they expect one-fifth more than from those spinning in twenty-eight days, and twice as much as from those spinning in thirty to forty days.

Chinese and Japanese feed often, but little at each time. In Europe great importance is attached to the use of wild mulberry leaves, which contain more food and less water in a given weight; for the same reason the large leaved varieties, formerly preferred and cultivated in silk-growing lands, are now rejected. There are as many varieties of the mulberry as of the silk-worm, and often on the same tree no two leaves will be found alike. If by wild mulberry we mean trees grown on poor and dry land, and which, never being plucked, are covered with numerous small twigs and leaves, I would say that no extensive silk culture could follow their use. Silk culture

demands a well arranged mulberry culture, but just as soon as the mulberry is transplanted to better land, manured, watered, and plucked, it changes to an improved variety; in a single year the little sapless, leathery leaves change to large luxuriant leaves. The great influence upon the leaves of cropping the trunk and branches we see in all forest trees, for when a forest is cut down and grows again from sprouts, the leaves are generally of extraordinary size and luxuriance.

Instead of the above advice, I would say, lay out your plantation on high, well drained ground, not on wet or swamp land. Do not water the trees too much, and do not cut them back, for if robbed to too great an extent of their leaves and twigs, the reserve strength that would have formed bark and fibre, is consumed in new leaves and twigs, so that in the following year the harvest of leaves is less, and the quality is not so good. This degeneration is greatest when two generations of silk worms of the Bivoltini race are raised in the same year. It should therefore be a rule to use a tree only every other year.

As moths from the earliest worms are used for breeding, those from the stragglers should be rigorously excluded. The earliest moths are also ordinarily excluded because they are few in number. The moths which appear with great regularity between half-past four and seven o'clock in the morning, should not be allowed to pair immediately; they should rest at least an hour; firstly, to develop fully their wings and strength; secondly, to pass off the liquid secretion. The paired moths should not be separated before 3 o'clock in the afternoon; the separation should be very carefully done; the body of the female should be held in the fingers of the left hand, that of the male in the fingers of the right hand and he should then be turned slowly on his axis, without pulling or jerking; ordinarily they separate very easily; but should this not happen, put the pair back and repeat the operation again after a short time. The separated females, on stretched sheeting or on paste-board, or paper, in order to secure a thick deposit of eggs, should be set close together, giving each about one square inch; for this purpose the cloth might be ruled out in square inches. If some females have not enough place, they can be changed to where an empty place is; it is wonderful how even a deposit of eggs is obtained, almost as even as the Japanese card-boards, which the inexperienced suppose to be artificially made. If the

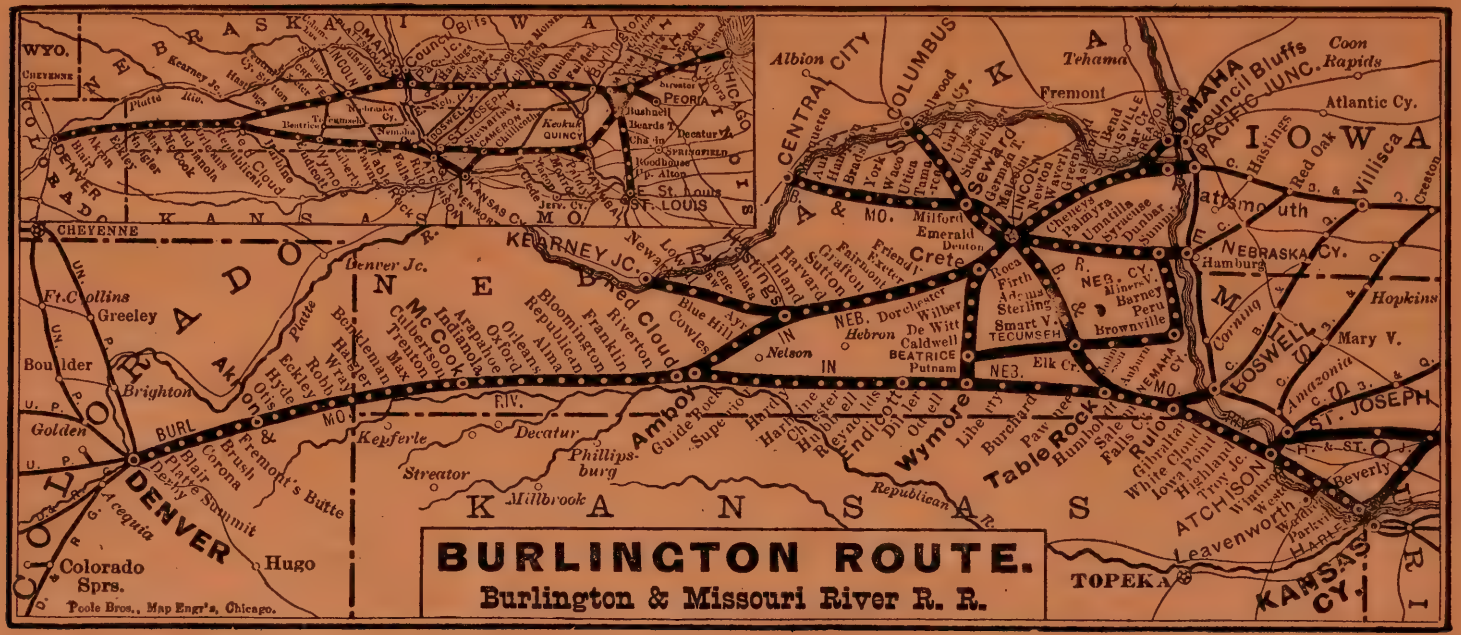
moths are too far apart it is very difficult to fill up the gaps equally.

On the same cloth or paste-board only females hatched the same morning ought to be used. Their number is to be noted, also the weight of the empty and the covered card-board or cloth, so that after calculating the weight of 1,000 eggs it is possible to determine the total number of eggs, as also the average production of each female.

Until the next morning, the females will have deposited most of their eggs. They are now removed and allowed to deposit the remainder on a separate board. Among these last eggs, many will retain their yellow color; this may be a sign of being unimpregnated; but this is not always the case, because every grower knows that from eggs which remain yellow worms have developed. Among silk worms the so-called *Parthenogenesis* sometimes occurs, and accordingly unimpregnated eggs might hatch, but this is very rare; of 2,000 unimpregnated eggs, only one will develop, while the development of a yellow egg from an impregnated female is very common.

SHORT RULES.

1. Select the best cocoons for eggs.
2. As soon as the moths creep out, keep only the finest, hardest, whitest, and in the yellow sort the lightest yellow.
3. Kill all spotted and damaged looking moths.
4. Keep the eggs in winter as near the freezing point as possible. A variation of temperature from zero Fahrenheit to 55° Fahrenheit does not harm the eggs.
5. Never allow the worms to fast long.
6. Never allow mould to form on the frames.
7. Regulate changes of temperature as carefully for the worms as for your own family.
8. Do not pile on too many leaves, as mould is apt to form.
9. As soon as the worms want to spin, give them spin-heaths, otherwise they waste silk.
10. Three days after the spinning collect the cocoons for reeling.
11. If you have no reel, kill the chrysalides in the cocoon, otherwise it will develop into a moth in 17 to 20 days.
12. The best cocoons keep for eggs.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Hamburg
Hopkins
Mary V.
Corning
BOSWELL
ST. JOSEPH
Amazonia
Beverly
ATCHISON
Leavenworth
KANSAS CY.
TOPEKA
Tabor
Sidney
Plattsmouth
Weeping Water
Union
Nehawka
Louisville
Ashland
Wahoo
Yutica
York
Seward
Milford
Emerald
Denton
Crete
Friendly
Exeter
Fairmont
Grafton
Sutton
Harvard
Inland
Hastings
Blue Hill
Cowles
Red Cloud
Franklin
Riverton
Bloomington
Republican
Alma
Orleans
Oxford
Arapahoe
Indianola
McCook
Culbertson
Trenton
Max
Bonkelman
Haxtun
Wray
Robb
Eckley
Hyde
Otis
Akron
Platte
Denver Jc.
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BEATRICE
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TECUMSEH
Barney
Peru
Brownville
Milners
Cheneys
Palmyra
Unadilla
Syracuse
Dunbar
Cheyenne
Ft. Collins
Greeley
Boulder
Brighton
Golden
Denver
Colorado Sprs.
Hugo
Acequia
Strasburg
Deshay
Blair
Platte
Brush
Corona
Fremont's Butte
Kelferle
Decatur
Streator
Phillipsburg
Millbrook
Republican R.
Amboy
Guide Rock
Superior
Harbine
Chester
Hubbell
Reynolds
Endicott
Daller
Wymore
Liberty
Burchard
Pawnee
Table Rock
Humboldt
Steinauer
Falls C.
Rulo
Gibraltar
White Cloud
Iowa Point
Highland
Troy Jc.
Whitehall
Weston
Parkville
Harlem
Albion
Central City
Columbus
Tekama
Fremont
Ashland
Milford
Emerald
Denton
Crete
Friendly
Exeter
Fairmont
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